

AD-A189 094

THE MAGNITUDE OF SECONDARY ELECTRON CONTRIBUTIONS IN
PHOTON SIMULATED SE. (U) GORDON WASHINGTON UNIV
WASHINGTON D C DEPT OF CHEMISTRY D E RAMAKER ET AL

1/1

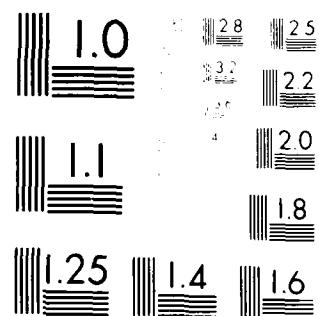
UNCLASSIFIED

DEC 87 TR-36 N00014-80-X-0032

F/G 7/4

ML

END
DATE
FILED
3-84
1984



AD-A189 094

4
JAN 07 1988

REPORT DOCUMENTATION PAGE	
1. REPORT SECURITY CLASSIFICATION Un. Classified	10. RESTRICTIVE MARKINGS
2. SECURITY CLASSIFICATION AUTHORITY	11. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public distribution, distribution unlimited
3. DECLASSIFICATION/DOWNGRADING SCHEDULE	12. MONITORING ORGANIZATION REPORT NUMBER(S)
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report # 36	5. NAME OF MONITORING ORGANIZATION Office of Naval Research (Code 413)
6a. NAME OF PERFORMING ORGANIZATION Dept. of Chemistry George Washington Univ.	6b. OFFICE SYMBOL (If applicable)
6c. ADDRESS (City, State, and Zip Code) Dept. of Chemistry/GWU 725, 21 Street, NW Washington, D.C. 20052	7a. NAME OF MONITORING ORGANIZATION Office of Naval Research (Code 413)
6d. NAME OF FUNDING/SPONSORING ORGANIZATION Office of Naval Research	7b. ADDRESS, State, and Zip Code Chemistry Program 800 N. Quincy Street Arlington, Virginia 22217
6e. OFFICE SYMBOL (If applicable)	8. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER Contract: N00014-80-K-0852
8c. ADDRESS (City, State, and Zip Code) Chemistry Program 800 N. Quincy, Arlington, VA 22217	9. SOURCE OF FUNDING NUMBERS PROGRAM NO. 61152N PROJECT NO. R0015-08 TAK NO. P0015-08-01 WORK UNIT NO. R (05-081)
11. TITLE (Include Security Classification) The Magnitude of Secondary Electron Contributions in Photon Stimulated Desorption	10. DATE OF REPORT (Year, Month, Day) 16 December 1987
12. PERSONAL AUTHOR(S) D. E. Ramaker, T. E. Mahey, R. L. Kurtz, and H. Sambe	11b. TIME COVERED 16 December 1987
13a. TYPE OF REPORT Technical Report	14. DATE OF REPORT (Year, Month, Day) 16 December 1987
13b. DISTRIBUTION/AVAILABILITY OF REPORT Contributions in Desorption Induced Electronic Transitions, DIET III, (Springer Series in Surface Sci.)	15. PAGE COUNT 5
16. SUPPLEMENTARY NOTATION Prepared for Publication in Desorption Induced Electronic Transitions, DIET III, (Springer Series in Surface Sci.)	
17. COSAN CODES	18. SUBJECT TERMS (Condone on reverse if necessary and identify by block number) · Photon Stimulated Desorption · Secondary electrons
FIELD	GROUP
19. ABSTRACT (Condone on reverse if necessary and identify by block number)	
<p>Recent reports on the extent of secondary electron contributions in electron/photon stimulated desorption (ESD/PSD) appear to be contradictory. JAICER et al. suggested that secondary electrons provide the dominant contribution to the H^+ yield from NH_3/Ni and called the process x-ray induced ESD (XESD). Others have concluded that the XESD process is the dominant mechanism in the PSD of N^+ and O^+ ions from the mixed condensed gases such as N_2 and O_2 and in the PSD of H^+ ions from $OH/FeO/Sm$. On the other hand, considerable evidence exists in the literature for the dominance of the direct photon excitation mechanisms. This paper presents a re-examination of the three systems mentioned above where a dominant XESD effect has been postulated to determine the validity of the conclusions previously reached.</p>	
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Dr. David L. Nelson	22b. TELEPHONE (include Area Code) (703) 696-4410
23. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	
DO FORM 1473, 84 MAR A copy of this document may be used until exhausted. All other editions are obsolete.	

The Magnitude of Secondary Electron Contributions in Photon Stimulated Desorption

D.E. Rimaker, T.E. Madey, and R.L. Kurtz
Surface Science Division, National Bureau of Standards
Gaithersburg, MD 20899

and

H. Sambe
Chemistry Department, George Washington University
Washington, DC 20052

1. Introduction

Recent reports on the extent of secondary electron contributions in electron/photon stimulated desorption (ESD/PSD) appear to be contradictory. JAEGER et al. [1] suggested that secondary electrons provide the dominant contribution to the H⁺ yield from NH₃/Ni and called the process X-ray induced ESD (XESD). Others have concluded that the XESD process is the dominant mechanism in the PSD of N⁺ and O⁺ ions from mixed condensed gases such as N₂ and O₂ [2] and in the PSD of H⁺ ions from OH/YBO₃-Sm [3]. On the other hand, considerable evidence exists in the literature for the dominance of the direct photon excitation mechanisms. This evidence usually comes from observed differences between the ion yield and the secondary electron yield or from the absence of any clear structure or "turn on" at certain core levels [4].

It seems clear that the magnitude of the XESD effect is generally not known, but this is an important question. Most helpful in sorting out the complex mechanisms in PSD has been the comparison of the photon energy dependence of the ion spectral yield with constant initial state photoselection spectra [5]. However, if the ion yield is dominated by effects from the secondary and back-scattered electrons, then this comparison provides no information because the ion yield will simply reflect the bulk DOS, regardless of the excitation involved. Moreover, the usefulness of PSD extended x-ray absorption fine structure (EXAFS) measurements for obtaining information on surface structure [6] will be highly limited if XESD contributions dominate. This paper presents a re-examination [4] of the three systems mentioned above where a dominant XESD effect has been postulated to determine the validity of the conclusions previously reached.

2. H⁺ from NH₃/Ni

The H⁺ yield spectrum from NH₃/Ni(110), where the NH₃ layer was believed by JAEGER et al. [1] to have an appreciable thickness, reveals the Ni L edge [1]. This suggests that the XESD mechanism must be acting, if indeed all Ni atoms are separated by many NH₃ layers from the outer surface. Furthermore, at the N K edge, the total electron yield (TEY) and H⁺ yields are very similar except for the presence of a shoulder in the H⁺ yield which is not present in the TEY. This shoulder was interpreted by JAEGER et al. [1] to arise from the direct core level excitation of a surface NH₃ molecule, the remainder of the yield spectrum arising from the XESD mechanism. Based on this interpretation, the XESD process is estimated to cause 60% of the total yield.

Our thermal desorption studies and other data indicate, however, that the thickness of the Ni₃ films used by JAEGER et al. [1] were considerably different from those which they reported [4]. We also indicate that the observed shoulder in the H⁺ yield arises because the 1s_{1/2} excitation at this energy has a higher branching ratio for the desorption process than for excitation into the Rydberg or continuum orbitals [4]. This is indicated because of the antibonding character of the 4s₁ orbital. Thus we do not believe that sufficient evidence has been provided to indicate that the XESD contribution is dominating in this case; indeed, we believe that the difference between the TEY and the H⁺ yield provides evidence that it is not dominant.

3. O⁺ and N⁺ from N₂-O₂

Recently PARKS et al. [2] reported the TEY and O⁺ and N⁺ yields from a condensed mixture of N₂ and O₂. The presence of large N⁺ and O⁺ yields at both the N and O K levels indicates very strongly that the XESD mechanism is playing an important role; indeed, they concluded that the XESD mechanism dominates for N⁺, but is small for O⁺ desorption.

PARKS et al. [2] analyzed their data on the basis of absolute quantities, namely on their experimental absolute ion yields and photon fluxes, and on previously reported photoionization cross-sections. The latter in particular are not known very accurately. We prefer to rely on the TEY which they reported, indeed a simple comparison of the TEY and O⁺ and N⁺ spectral yield curves indicates that the O⁺ yield is very similar to the TEY, while the N⁺ is very different [4]. This indicates, contrary to the above, that the O⁺ yield is dominated by the XESD mechanism, while the N⁺ yield is not. A detailed analysis indicates that the XESD cross section for N⁺ and O⁺ are comparable, but that the direct cross section for N⁺ is 20 times that for O⁺ [4].

The primary core level dissociation process in diatomics involves Auger decay of the core hole, resulting in a two-hole (2h) final state, which directly results in dissociation via a "Coulomb explosion". This Auger stimulated desorption (ASD) mechanism is known to be active in the gas phase [7], and it is believed to be active also in the condensed phase, at least for N₂ and CO [7]. We believe that a similar mechanism is appropriate in the condensed N₂-O₂ mixture, only in this case an electron transfer occurs from a resonant 2s¹ orbital of a neighboring O₂ molecule [4]. This transferred electron screens the two valence holes caused by the Auger decay and thus prevents the ASD process. This electron transfer cannot occur in condensed N₂ because the comparable 2s¹ orbital is empty.

Evidence that this charge transfer process can occur in O₂ comes from visible absorption spectra. Isolated O₂ dimers in a solid neon host have a characteristic absorption spectrum [8] resulting from absorption of a single photon to produce a singlet state in which both halves of the dimer are electronically excited. The electronic energy transfer is believed to result from electron exchange of the 2s¹ electron [8]. Furthermore, recent absorption and photoelectron data on condensed N₂ and O₂ reveal that the 2s¹ band is significantly broadened by normal intermolecular interactions [9]. Finally, direct evidence has been given recently indicating that 2s¹ electron transfer does occur in condensed NO [10].

4. H* from OH-YbO/Sm

Finally, the H* yield from an oxidized Yb surface on a bulk Sm metal substrate shows large features which arise from the Sm and Yb 4d-4f giant resonances [3]. Although little of the Sm surface is thought to be exposed, the Sm feature is much larger than the Yb feature. If indeed the Sm surface is totally covered, this strongly indicates that the XESD process is dominant in this system. The H* which desorbs is most likely bonded to the O atoms in the oxidized Yb. The giant resonance, 4d-4f*, Auger decays or autoionizes predominantly to 4f*, a one-hole valence state which does not lead to desorption. Thus, the direct ASD process is inactive at both the Yb and Sm core levels, and the XESD process is expected to dominate [4].

5. Summary

It has been shown for the three systems discussed above that either alternate interpretations of the data are possible, indicating that the XESD effect is not dominant, or that the XESD process dominates only because the direct ASD mechanism is suppressed. This makes the results on these three systems consistent with the significantly larger number of papers, which indicate that the XESD contribution is generally not dominant [4]. We conclude that in cases for which the direct core level ASD process is active, the indirect XESD contribution is generally on the order of 35% or less. The XESD contribution apparently dominates the total yield only in those cases when the direct ASD contribution is suppressed.

References

1. R. Jaeger and J. Stohr: Phys. Rev. B28, 1145 (1983); R. Jaeger, J. Stohr, and T. Kendelevic: Surf. Sci. 134, 547 (1983).
2. C.C. Parks, Lawrence Berkeley Laboratory Report LBL-16802, Nov. 1983; V. Rehn and R.A. Rosenberg: Synchrotron Radiation Research: Advances in Surface and Low-Dimensional Science, ed. by R.Z. Bachrach (Plenum Publishing, New York, 1987).
3. J. Schmidt-May, F. Senf, J. Voss, C. Kunz, A. Flodstrom, R. Nyholm, and R. Stoerzinger: Desorption Induced by Electronic Transitions, DIFT II, ed. by W. Brenig and D. Menzel, Springer Ser. Surf. Sci., Vol. 4 (Springer, Berlin, Heidelberg 1985) p. 94; also Surf. Sci. 163, 383 (1985).
4. D.E. Ramaker, T.E. Mac'ay, R.L. Kurtt, and H. Sambe: to be published.
5. D.E. Ramaker: P-70 in Ref. 3 above
6. R. Jaeger, J. Stohr, J. Feldhaus, S. Brennen, and D. Menzel, Phys. Rev. B23, 2101 (1981).
7. T.A. Carlson and M.O. Krause: J. Chem. Phys. 56, 3206 (1972); B. Brehm and G. de Frene, Int. J. Mass Spect. Ion Phys. 26, 251 (1978).
8. J. Goodman and L.E. Brus: J. Chem. Phys. 67, 4398 (1977); 67, 4408 (1977).
9. H.J. Lau, J.H. Fock, and E.E. Koch: Chem. Phys. Lett. 89, 281 (1982); J.H. Fock and E.E. Koch: Ann. Isr. Phys. Soc. 5, 285 (1984).
10. B.B. Tonner, C.M. Kao, E.W. Plummer, T.C. Caves, R.P. Messmer, and W.R. Salaneck: Phys. Rev. Lett. 51, 1378 (1983).

TECHNICAL REPORT DISTRIBUTION LIST, GEN

D/1113/87/2

ABSTRACTS DISTRIBUTION LIST, 056/625/629

D/1113/87/2

No.	Copies	No.	Copies
Office of Naval Research	2	Dr. David Young	1
Attn: Code 1113 800 N. Quincy Street Arlington, Virginia 22217-5000		Code 334 NORDA NSTL, Mississippi 39529	
Dr. Bernard Dauda Naval Weapons Support Center Code 500 Crane, Indiana 47522-5050	1	Naval Weapons Center Attn: Dr. Ron Atkins Chemistry Division China Lake, California 93555	1
Naval Civil Engineering Laboratory Attn: Dr. R. W. Drisio, Code L2 Port Hueneme, California 93401	1	Scientific Advisor Commandant of the Marine Corps Code RD-1 Washington, D.C. 20380	1
Defense Technical Information Center Building 5, Cameron Station Alexandria, Virginia 22314	1	U.S. Army Research Office Attn: CGA-1P P.O. Box 12211 Research Triangle Park, NC 27709	1
DTNSRDC Attn: Dr. H. Singerman Applied Chemistry Division Annapolis, Maryland 21401	1	Mr. John Boyle Materials Branch Naval Ship Engineering Center Philadelphia, Pennsylvania 19110	1
Dr. William Tolles Superintendent Chemistry Division, Code 6100 Naval Research Laboratory Washington, D.C. 20375-5000	1	Naval Ocean Systems Center Attn: Dr. S. Yamamoto Marine Sciences Division San Diego, California 91232	1

No.	Copies	No.	Copies
Dr. F. Carter	Code 6170 Naval Research Laboratory Washington, D.C. 20375-5000	Dr. John T. Yates	Department of Chemistry University of Pittsburgh Pittsburgh, Pennsylvania 15260
Dr. Richard Colton	Code 6170 Naval Research Laboratory Washington, D.C. 20375-5000	Dr. R. Stanley Williams	Department of Chemistry University of California Los Angeles, California 90024
Dr. Dan Pierce		Dr. R. P. Messmer	Materials Characterization Lab. General Electric Company Schenectady, New York 22217
Dr. R. G. Wallis		Dr. J. T. Keiser	Department of Chemistry University of Richmond Richmond, Virginia 23173
Dr. D. Ramaker		Dr. R. W. Plummer	Department of Physics University of Pennsylvania Philadelphia, Pennsylvania 19104
Dr. J. C. Heiminger		Dr. E. Yeager	Department of Chemistry Case Western Reserve University Cleveland, Ohio 44106
Dr. T. F. George		Dr. N. Winograd	Department of Chemistry Pennsylvania State University University Park, Pennsylvania 16802
Dr. Roald Hoffmann		Dr. Robert L. Whetten	Department of Chemistry Cornell University Ithaca, New York 14853
Dr. Galen D. Stucky		Dr. Daniel M. Neumark	Department of Chemistry University of California Berkeley, CA 94720

73	Distribution / Availability Codes	74	75
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100
101	101	101	101
102	102	102	102
103	103	103	103
104	104	104	104
105	105	105	105
106	106	106	106
107	107	107	107
108	108	108	108
109	109	109	109
110	110	110	110
111	111	111	111
112	112	112	112
113	113	113	113
114	114	114	114
115	115	115	115
116	116	116	116
117	117	117	117
118	118	118	118
119	119	119	119
120	120	120	120
121	121	121	121
122	122	122	122
123	123	123	123
124	124	124	124
125	125	125	125
126	126	126	126
127	127	127	127
128	128	128	128
129	129	129	129
130	130	130	130
131	131	131	131
132	132	132	132
133	133	133	133
134	134	134	134
135	135	135	135
136	136	136	136
137	137	137	137
138	138	138	138
139	139	139	139
140	140	140	140
141	141	141	141
142	142	142	142
143	143	143	143
144	144	144	144
145	145	145	145
146	146	146	146
147	147	147	147
148	148	148	148
149	149	149	149
150	150	150	150
151	151	151	151
152	152	152	152
153	153	153	153
154	154	154	154
155	155	155	155
156	156	156	156
157	157	157	157
158	158	158	158
159	159	159	159
160	160	160	160
161	161	161	161
162	162	162	162
163	163	163	163
164	164	164	164
165	165	165	165
166	166	166	166
167	167	167	167
168	168	168	168
169	169	169	169
170	170	170	170
171	171	171	171
172	172	172	172
173	173	173	173
174	174	174	174
175	175	175	175
176	176	176	176
177	177	177	177
178	178	178	178
179	179	179	179
180	180	180	180
181	181	181	181
182	182	182	182
183	183	183	183
184	184	184	184
185	185	185	185
186	186	186	186
187	187	187	187
188	188	188	188
189	189	189	189
190	190	190	190
191	191	191	191
192	192	192	192
193	193	193	193
194	194	194	194
195	195	195	195
196	196	196	196
197	197	197	197
198	198	198	198
199	199	199	199
200	200	200	200
201	201	201	201
202	202	202	202
203	203	203	203
204	204	204	204
205	205	205	205
206	206	206	206
207	207	207	207
208	208	208	208
209	209	209	209
210	210	210	210
211	211	211	211
212	212	212	212
213	213	213	213
214	214	214	214
215	215	215	215
216	216	216	216
217	217	217	217
218	218	218	218
219	219	219	219
220	220	220	220
221	221	221	221
222	222	222	222
223	223	223	223
224	224	224	224
225	225	225	225
226	226	226	226
227	227	227	227
228	228	228	228
229	229	229	229
230	230	230	230
231	231	231	231
232	232	232	232
233	233	233	233
234	234	234	234
235	235	235	235
236	236	236	236
237	237	237	237
238	238	238	238
239	239	239	239
240	240	240	240
241	241	241	241
242	242	242	242
243	243	243	243
244	244	244	244
245	245	245	245
246	246	246	246
247	247	247	247
248	248	248	248
249	249	249	249
250	250	250	250
251	251	251	251
252	252	252	252
253	253	253	253
254	254	254	254
255	255	255	255
256	256	256	256
257	257	257	257
258	258	258	258
259	259	259	259
260	260	260	260
261	261	261	261
262	262	262	262
263	263	263	263
264	264	264	264
265	265	265	265
266	266	266	266
267	267	267	267
268	268	268	268
269	269	269	269
270	270	270	270
271	271	271	271
272	272	272	272
273	273	273	273
274	274	274	274
275	275	275	275
276			

ABSTRACTS DISTRIBUTION LIST, 056/625/629

Dr. J. E. Jenson
Hughes Research Laboratory
3011 Malibu Canyon Road
Malibu, California 90265

Dr. J. H. Weaver
Department of Chemical Engineering
and Materials Science
University of Minnesota
Minneapolis, Minnesota 55455

Dr. A. Reisman
Microelectronics Center of North Carolina
Research Triangle Park, North Carolina
27709

Dr. M. Grunze
Laboratory for Surface Science
and Technology
University of Maine
Orono, Maine 04469

Dr. J. Butler
Naval Research Laboratory
Code 6115
Washington, D.C. 20375-5000

Dr. L. Interante
Chemistry Department
Rensselaer Polytechnic Institute
Troy, New York 12181

Dr. Irvin Heard
Chemistry and Physics Department
Lincoln University
Lincoln University, Pennsylvania 19352

Dr. K. J. Klaubunde
Department of Chemistry
Kansas State University
Manhattan, Kansas 66506

Dr. C. B. Harris
Department of Chemistry
University of California
Berkeley, California 94720

Dr. R. Bruce King
Department of Chemistry
University of Georgia
Athens, Georgia 30602

Dr. Richard J. Saykally
Department of Chemistry
University of California
Berkeley, California 94720

Dr. R. Reeves
Chemistry Department
Rensselaer Polytechnic Institute
Troy, New York 12181

Dr. Steven M. George
Stanford University
Stanford, CA 94305

Dr. Mark Johnson
Yale University
Department of Chemistry
New Haven, CT 06511-8118

Dr. W. Knauer
Hughes Research Laboratory
3011 Malibu Canyon Road
Malibu, California 90265

Dr. Theodore E. Magey
Surface Chemistry Section
Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

Dr. J. E. Demuth
IBM Corporation
Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, New York 10598

Dr. M. G. Legally
Department of Metallurgical and
Mining Engineering
University of Wisconsin
Madison, Wisconsin 53706

Dr. R. P. Van Duyne
Chemistry Department
Northwestern University
Evanson, Illinois 60237

Dr. J. M. White
Department of Chemistry
University of Texas
Austin, Texas 78712

Dr. K. J. Somorjai
Department of Chemistry
University of California
Berkeley, California 94720

Dr. R. L. Kesmodel
Department of Physics
Indiana University
Bloomington, Indiana 47403

Dr. J. Murday
Naval Research Laboratory
Code 6170
Washington, D.C. 20375-5000

Dr. W. T. Peria
Electrical Engineering Department
University of Minnesota
Minneapolis, Minnesota 55455

Dr. Keith H. Johnson
Department of Metallurgy and
Materials Science
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Dr. S. Sibener
Department of Chemistry
James Franck Institute
5640 Ellis Avenue
Chicago, Illinois 60637

Dr. Arnold Green
Quantum Surface Dynamics Branch
Code 3817
Naval Weapons Center
China Lake, California 93555

Dr. A. Wild
Department of Chemistry
Brown University
Providence, Rhode Island 02912

Dr. S. L. Bernick
Department of Chemistry
Princeton University
Princeton, New Jersey 08544

Dr. W. Kohn
Department of Physics
University of California, San Diego
La Jolla, California 92093

Dr. Stephen C. Kevan
Physics Department
University Of Oregon
Eugene, Oregon 97403

Dr. Richard J. Saykally
Department of Chemistry
University of California
Berkeley, California 94720

Dr. K. C. Janda
University of Pittsburgh
Chemistry Building
Pittsburgh, PA 15260

Dr. E. A. Irene
Department of Chemistry
University of North Carolina
Chapel Hill, North Carolina 27514

Dr. Adam Heller
Bell Laboratories
Murray Hill, New Jersey 07974

Dr. Martin Fleischmann
Department of Chemistry
University of Southampton
Southampton SO9 5NH
UNITED KINGDOM

Dr. H. Tachikawa
Chemistry Department
Jackson, Mississippi 39217

Dr. John W. Wilkins
Cornell University
Laboratory of Atomic and
Solid State Physics
Ithaca, New York 14853

Dr. Ronald Lee
R201
Naval Surface Weapons Center
White Oak
Silver Spring, Maryland 20910

Dr. Robert Gomer
Department of Chemistry
James Franck Institute
5640 Ellis Avenue
Chicago, Illinois 60637

Dr. Horia Metiu
Chemistry Department
University of California
Santa Barbara, California 93106

Dr. W. Goddard
Department of Chemistry and Chemical
Engineering
California Institute of Technology
Pasadena, California 91109

